

Application No. 10/612,069
Amendment dated July 2, 2007
Reply to Office Action of March 30, 2007

Docket No.: 0142-0416P

AMENDMENTS TO THE DRAWINGS

The attached sheet(s) of drawings includes changes to Figs. 4A, 4B, 5A, and 5B.

Attachment: Two Replacement sheets

REMARKS

Claims 1 and 7 have been rejected by the Examiner under 35 USC 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the Applicants regard as the invention. More specifically, the Examiner has objected to the use of the phrase “and/or” which is present in both claims 1 and 7. As the Examiner will note, claims 1 and 7 have been amended to eliminate the expression objected to by the Examiner and accordingly it is believed that this rejection has been eliminated.

As the Examiner will note, new Figs. 4A, 4B, 5A and 5B are submitted herewith as replacement figures for those presently existing in the present application, said new figures being submitted to correct the present existing figures and bringing them into compliance with the description as set forth on pages 14 and 15 of the present application. Thus a thorough reading of this portion of the specification will clearly indicate that the newly presented figures are in complete compliance with the description on pages 14 and 15 of the present application and accordingly the newly presented figures do not introduce new matter into the present application. Accordingly, the Examiner is respectfully requested to enter the newly presented figures as being a more accurate description of the subject matter of the present application.

Claims 1 and 4-8 have been rejected by the Examiner under 35 USC 103(a) as being unpatentable over Zhang, U.S. Patent 5,757,392 in view of Yasutomi, JP 410235860A. Also, claim 3 has been rejected by the Examiner under 35 USC 103(a) as being unpatentable over Zhang and Yasutomi as applied to claim 1 and further in view of Niikawa, US Patent 4,866,326. These rejections are respectfully traversed.

The present invention is directed to a method and device for controlling an ink jet printhead containing a substantially closed duct in which ink is situated, said duct having at least one exit opening for the ink, which comprises setting a required pressure change for obtaining an ink drop ejection in which the drop has a previously known size and/or speed. Applying an actuation pulse to an electromechanical transducer so that the pressure in the duct changes,

measuring the electrical impedance of the electromechanical transducer, real time, during the application of said pulse and real time adapting the same actuation pulse on the basis of the measuring impedance to obtain the said required pressure change, thus ejecting an ink drop having the previously known size and/or speed from the exit opening.

Zhang is directed to a piezoelectric type liquid droplet ejecting device which is adapted to compensate for residual pressure fluctuations. Thus, the control method taught by Zhang patent comprises negating the residual pressure fluctuations in ink drops by applying additional drive pulses that induce pressure waves opposite to the pressure wave created by the drop-forming pulse (actuation). In other words, an ink drop has already been ejected before the control action that negates the residual pressure fluctuation in the ink duct. This suggests that according to the teachings of Zhang, the drop size and/or drop speed can only be adjusted for subsequent droplets. Even in the first example of the third embodiment (see Col. 16, line 20 to Col. 17, line 9) where multiple pulses are applied to create larger droplets (i.e., drop-size modulation; 441, 442 and 443 in Fig. 20), a smaller droplet is ejected from the nozzle by only applying pulse 441 (see Col. 16, lines 22-27). In contrast thereto, the method of the present invention enables the adaptation of the drop-forming pulse while it is being applied (real-time), based on the measured impedance during the said drop-forming pulse. The pressure change in the ink duct is controlled within a predetermined range to maintain a substantially constant ink drop size and/or ink drop speed as recited in claim 1 of the present application.

Zhang also teaches the use of a separate piezoelectric sensor (element 60, Fig. 17) that enables the measurement of the pressure fluctuation during actuation of the piezoelectric actuator (see element 16C in Fig. 17). However, there are several disadvantages to this method. First of all, the induced pressure change will be detected by the sensor with considerable inertia because the induced wave must travel through the ink and induce an electrical signal at the piezoelectric sensor that is located elsewhere. This makes the measured signals susceptible to all kinds of perturbances in the ink duct and thus makes "real-time" control more difficult. Furthermore, the induced pressure change will, in itself, induce a deformation of both the actuating and the

sensing piezoelectric elements (16C and 60, respectively). Therefore, the measured signal will be influenced by the induced deformation of the piezoelectric actuator (16C), which makes it an unreliable signal upon which to base a control action. The method of the present invention overcomes these drawbacks by continuously measuring the impedance of the piezoelectric transducer in adapting the actuation pulse during the actuation itself. Thus, even during the application of that part of the pulse that leads to the required pressure change for obtaining an ink drop ejection in which the drop has the previously known size and/or speed, the pulse can be adjusted to lead to the required pressure change and thus the required size and/or speed for the ink droplet. Thus, the method and device of the present invention have the same possibilities as the Zhang method, that is, to be able to correct unwanted residual effects after an ink droplet has been ejected from the pressure chamber, but has the very important additional advantage that the ink droplet ejection process and device can be adjusted, real-time, so as to provide droplets with required size and/or speed whereas in the Zhang method, this is an outcome which has to be accepted as it is.

Yasutomi teaches that resistance cannot be measured while breathing out the ink drop (see [0046]). In paragraph [0059] it is stated that instead of resistance, the impedance can also be used to detect physical properties. Yasutomi further teaches a method to overcome this problem, that is, "dummy channels" are introduced to perform as sensors (see Fig. 11 No. 350). This method is therefore only suitable to correct for the influences of parameters that are more or less common for all channels. The method of the present invention enables separate control for each individual channel and thus no dummy channels are required.

It is the Applicants' position that neither Zhang nor Yasutomi discloses the Applicants' inventive contribution and thus even, arguendo, it would be possible to combine the references as suggested by the Examiner said combination would still not suggest the present invention.

In rejecting claim 3 of the present application, the Examiner has further relied upon the teachings of Niikawa et al. However, in view of the deficiencies in Zhang and Yasutomi which

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have not and cannot be cured by the teachings of Niikawa et al., it is believed that for the same reasons as discussed hereinabove, it is believed that claim 3 is patentably distinguishable over any and all of the references relied upon by the Examiner either alone or in combination.

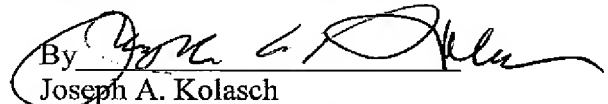
Accordingly, in view of the above amendments and remarks reconsideration of the rejections and allowance of all of the claims of the present application are respectfully requested.

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact Joseph A. Kolasch Reg. No. 22,463 at the telephone number of the undersigned below, to conduct an interview in an effort to expedite prosecution in connection with the present application.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37.C.F.R. §§1.16 or 1.14; particularly, extension of time fees.

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Respectfully submitted,

By 

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Attachments: Replacements Figs. 4A, 4B and 5A, 5B